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Lo

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(54) **GENERALIZED AUTO MEDIA SELECTOR**

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(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 211 days.

This patent is subject to a terminal disclaimer.

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Related U.S. Application Data

(63) Continuation of application No. 12/619,761, filed on Nov. 17, 2009, now Pat. No. 7,885,192, which is a continuation of application No. 11/201,111, filed on Aug. 10, 2005, now Pat. No. 7,619,975, and a continuation-in-part of application No. 10/435,301, filed on May 9, 2003, now Pat. No. 7,324,507, which is a continuation-in-part of application No. 09/991,046, filed on Nov. 21, 2001, now Pat. No. 7,054,309.

(60) Provisional application No. 60/667,731, filed on Apr. 1, 2005, provisional application No. 60/438,933, filed on Jan. 9, 2003.

(51) **Int. Cl.**
G01R 31/06 (2006.01)

(52) **U.S. Cl.**
USPC **370/235**; 370/360; 370/384; 370/469

(58) **Field of Classification Search**
USPC 370/235, 360, 384, 469
See application file for complete search history.

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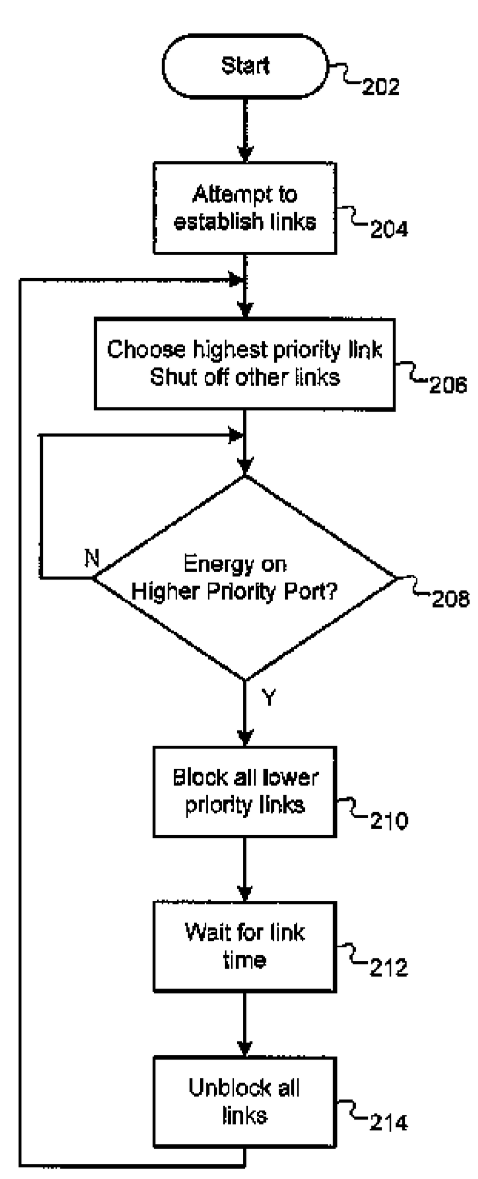
Primary Examiner — Sai-Ming Chan

(57) **ABSTRACT**

A media selection system includes a plurality of media ports. Each of the plurality of media ports is coupled to a corresponding physical medium, and each of the plurality of media ports is configured to generate an activity signal and a link status signal. A priority storage module is configured to contain priority information, which sets forth a priority for establishing a link through each of the plurality of media ports. A media selector module is configured to select a first media port through which a link will be maintained based on the link status signal generated by each of the plurality of media ports and the priority information. The media selector module is further configured to block all other links through media ports of the plurality of media ports other than the first media port.

12 Claims, 5 Drawing Sheets



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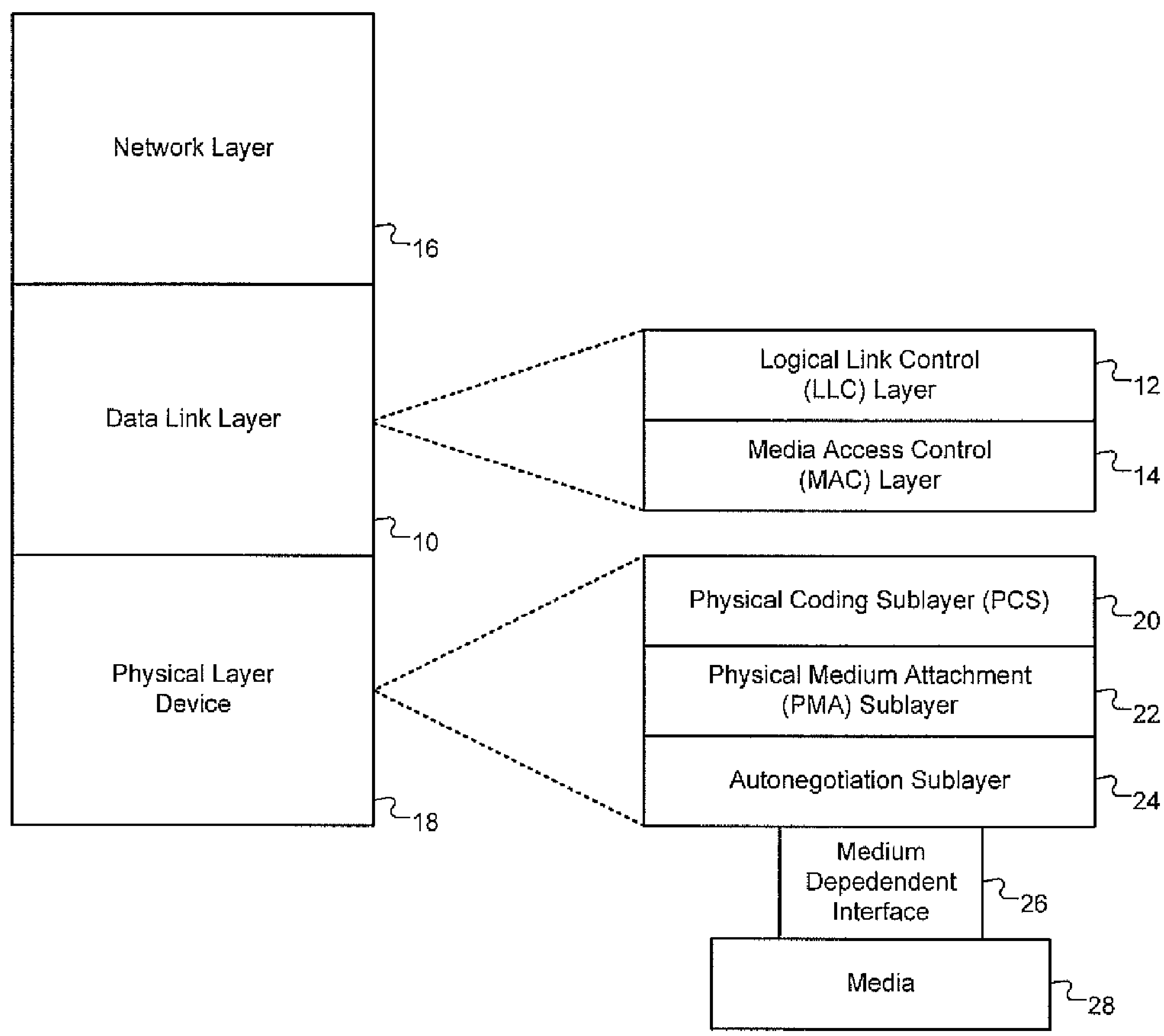

FIG. 1
Prior Art

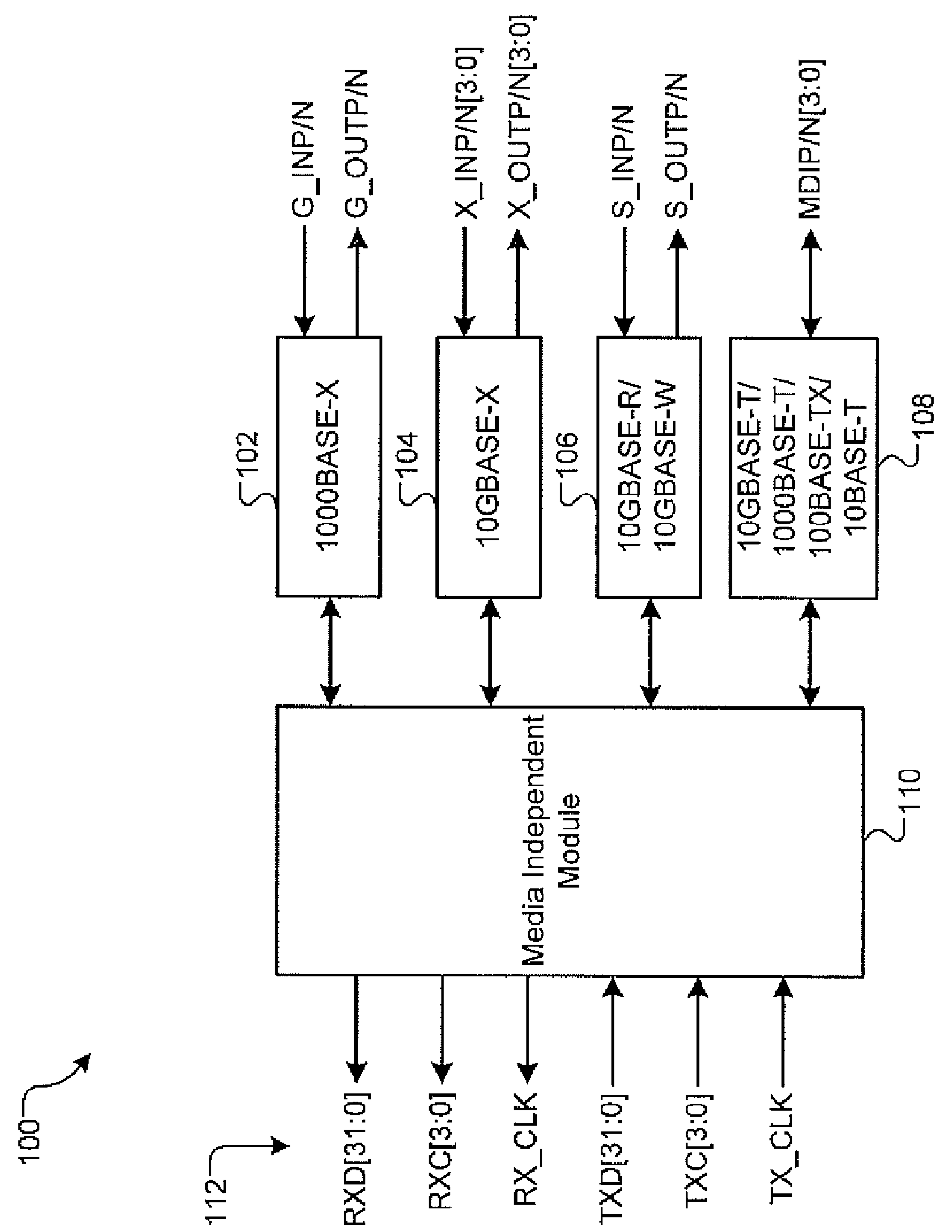
100
112
RXD[31:0]
RXC[3:0]
RX_CLK
TXD[31:0]
TXC[3:0]
TX_CLK
Media Independent Module
110
1000BASE-X
102
10GBASE-X
104
10GBASE-R/ 10GBASE-W
106
10GBASE-T/ 1000BASE-T/ 100BASE-TX/ 10BASE-T
108
G_INP/N
G_OUTP/N
X_INP/N[3:0]
X_OUTP/N[3:0]
S_INP/N
S_OUTP/N
MDIP/N[3:0]

FIG. 2

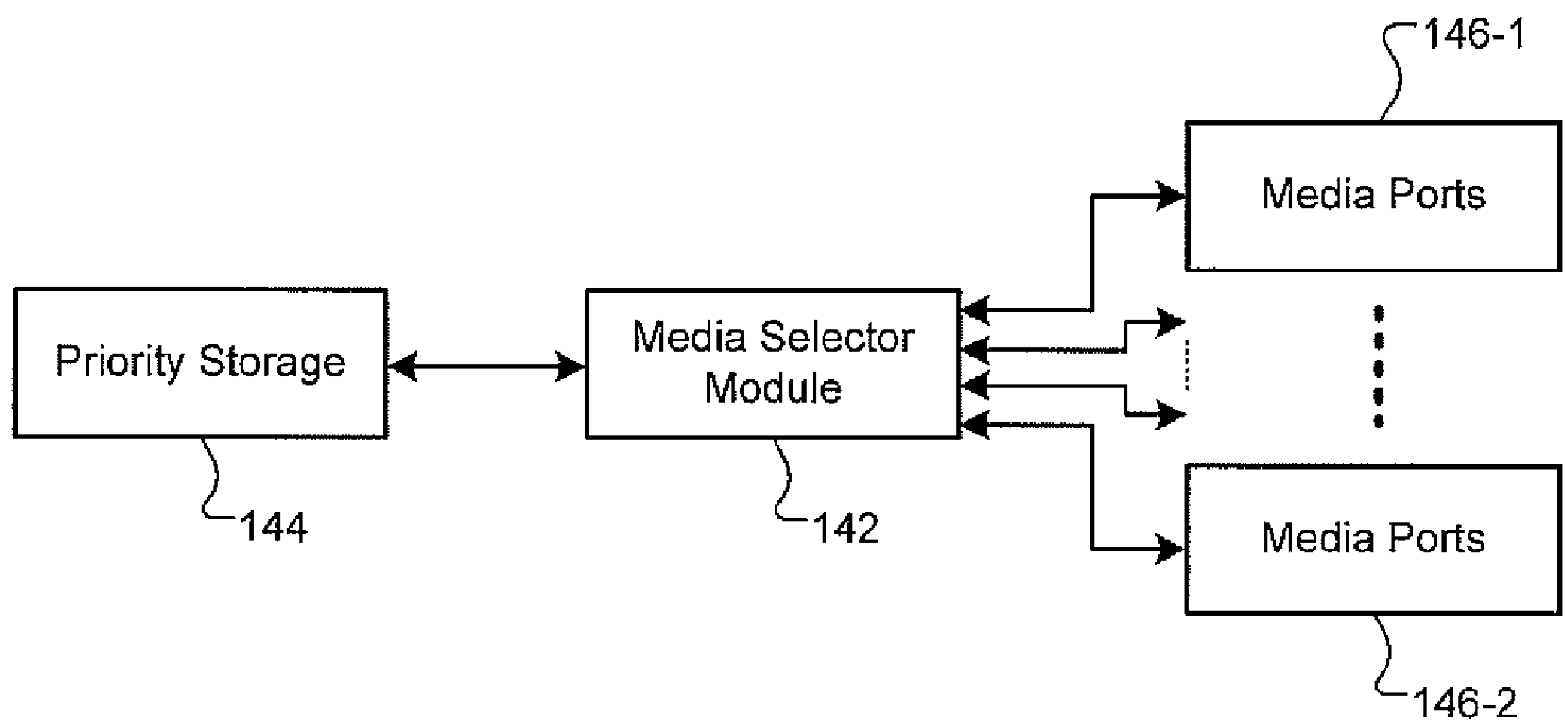
146-1
Media Ports
Priority Storage
Media Selector Module
Media Ports
144
142
146-2

FIG. 3

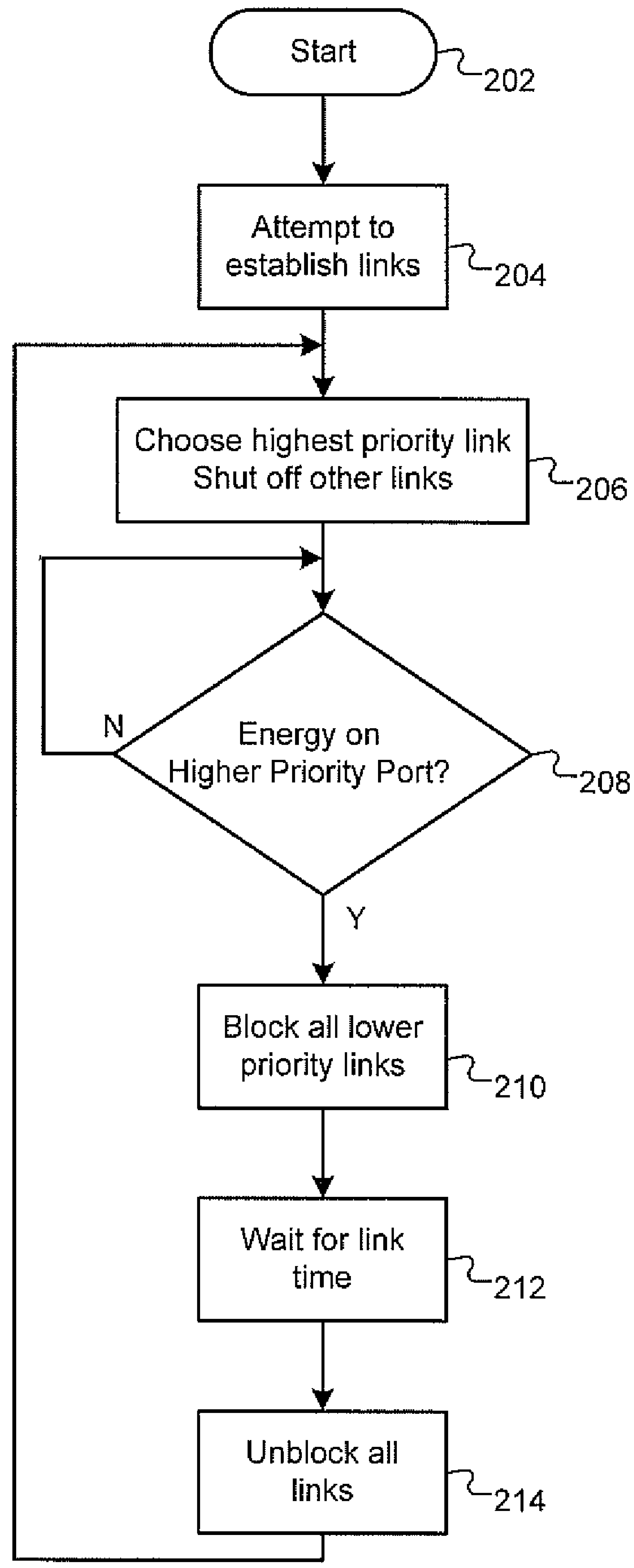
Start
202
Attempt to establish links
204
Choose highest priority link
Shut off other links
206
N
Energy on Higher Priority Port?
208
Y
Block all lower priority links
210
Wait for link time
212
Unblock all links
214

FIG. 4

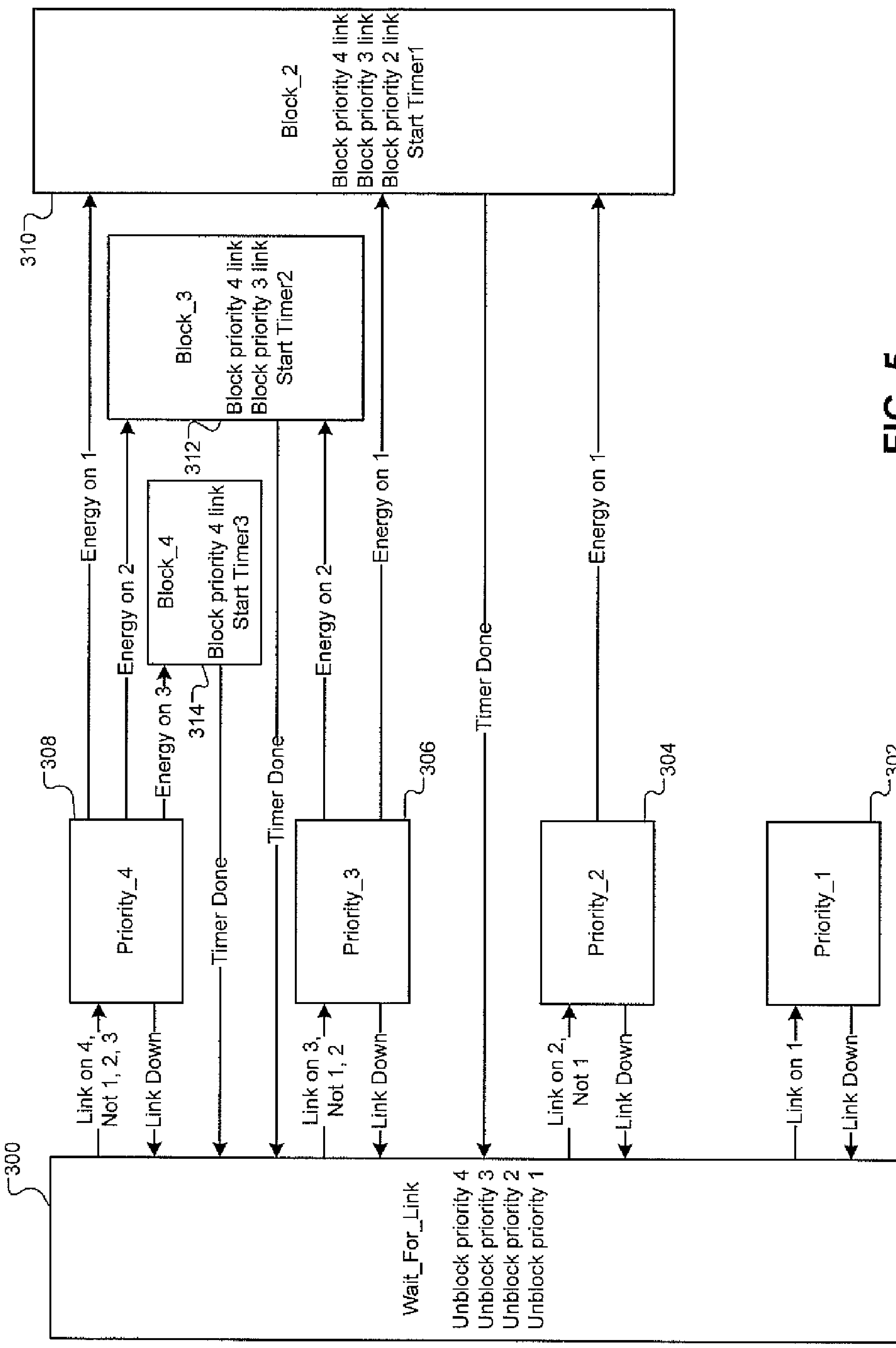
Block_2
Block priority 4 link
Block priority 3 link
Block priority 2 link
Start Timer1
310
Block_3
Block priority 4 link
Block priority 3 link
Start Timer2
312
Block_4
Block priority 4 link
Start Timer3
314
Energy on 1
Energy on 2
Energy on 3
Energy on 2
Energy on 1
Energy on 1
Timer Done
Timer Done
Timer Done
Priority_4
308
Priority_3
306
Priority_2
304
Priority_1
302
Link on 4,
Not 1, 2, 3
Link Down
Link on 3,
Not 1, 2
Link Down
Link on 2,
Not 1
Link Down
Link on 1
Link Down
300
Wait_For_Link
Unblock priority 4
Unblock priority 3
Unblock priority 2
Unblock priority 1

FIG. 5

GENERALIZED AUTO MEDIA SELECTOR

CROSS-REFERENCE TO RELATED APPLICATIONS

This application is a continuation of U.S. application Ser. No. 12/619,761 (now U.S. Pat. No. 7,885,192), filed on Nov. 17, 2009, which is a continuation of U.S. application Ser. No. 11/201,111 (now U.S. Pat. No. 7,619,975), filed on Aug. 10, 2005, which claims the benefit of U.S. Provisional Application No. 60/667,731, filed on Apr. 1, 2005. The disclosures of the above applications are hereby incorporated by reference herein in their entirety. U.S. application Ser. No. 11/201,111 (now U.S. Pat. No. 7,619,975), filed on Aug. 10, 2005, is a continuation-in-part of U.S. application Ser. No. 10/435,301 (now U.S. Pat. No. 7,324,507), filed on May 9, 2003, which is a continuation-in-part of U.S. application Ser. No. 09/991,046 (now U.S. Pat. No. 7,054,309), filed on Nov. 21, 2001 and claims the benefit of U.S. Provisional Application No. 60/438,933, filed on Jan. 9, 2003.

TECHNICAL FIELD

The present invention relates to computer networks, and more particularly to an automatic media selector.

BACKGROUND

Referring now to FIG. **1**, a data link layer **10** of the open systems interconnection (OSI) model includes a logical link control (LLC) layer **12** and a media access control (MAC) layer **14**. The LLC layer **12** addresses and exchanges data with a network layer **16**. The MAC layer **14** provides an interface between the LLC layer **12** and a physical layer device **18**. The MAC layer **14** frames data for transmission over the network and then passes the frame to the physical layer device **18** for transmission as a stream of bits. In other words, the MAC layer **14** frames data into distinct units or packets that are transmitted one at a time over the network.

The physical layer device **18** typically includes a physical coding sublayer (PCS) **20**, a physical medium attachment (PMA) sublayer **22**, and an autonegotiation sublayer **24**. A medium dependent interface (MDI) **26** connects the physical layer device **18** to media **28** such as twisted pair wires, optical fiber, or other media. The IEEE 802.3 specification, which is hereby incorporated by reference in its entirety, further defines how physical network interfaces operate with different types of media such as coaxial cable, twisted-pair cable, and optical fiber.

The autonegotiation sublayer **24** initiates the exchange of information between two connected network devices and automatically configures the devices to take maximum advantage of their respective abilities. The autonegotiation sublayer **24** advertises the abilities of the network device, acknowledges receipt, identifies common modes of operation, and rejects the use of operational modes that are not shared or supported by both devices. When more than one common mode of operation exists between the devices, an arbitration function of the autonegotiation layer **24** identifies and selects a single mode of operation. After autonegotiation is complete, the devices establish a link and exchange data.

To improve flexibility, the physical layer device **18** of some network devices has been designed to be connected to different types or speeds of media. Alternatively, multiple physical layer devices may be present to handle different types or speeds of media. The manufacturer and/or the user may not know a priori the types or speeds of media that will be used, and the media used may change over time.

SUMMARY

A media selection system includes a plurality of media ports. Each of the plurality of media ports is coupled to a corresponding physical medium, and each of the plurality of media ports is configured to generate an activity signal and a link status signal. A priority storage module is configured to contain priority information, which sets forth a priority for establishing a link through each of the plurality of media ports. A media selector module is configured to select a first media port through which a link will be maintained based on the link status signal generated by each of the plurality of media ports and the priority information. The media selector module is further configured to block all other links through media ports of the plurality of media ports other than the first media port.

In still other features, the methods described above are implemented by a computer program executed by one or more processors. The computer program can reside on a computer readable medium such as but not limited to memory, non-volatile data storage and/or other suitable tangible storage mediums.

Further areas of applicability of the present invention will become apparent from the detailed description provided after. It should be understood that the detailed description and specific examples, while indicating the preferred embodiment of the invention, are intended for purposes of illustration only and are not intended to limit the scope of the invention.

BRIEF DESCRIPTION OF THE DRAWINGS

The present invention will become more fully understood from the detailed description and the accompanying drawings, wherein:

FIG. **1** is a diagram of the open systems interconnection (OSI) model;

FIG. **2** is a functional block diagram of an exemplary physical layer device (PHY);

FIG. **3** is a functional block diagram of an exemplary media selection system for a PHY;

FIG. **4** is a flow chart depicting exemplary steps performed by a media selection system according to the principles of the present invention; and

FIG. **5** is an exemplary state diagram of a media selection system according to the principles of the present invention.

DETAILED DESCRIPTION

The following description of the preferred embodiments is merely exemplary in nature and is in no way intended to limit the invention, its application, or uses. For purposes of clarity, the same reference numbers will be used in the drawings to identify similar elements. As used, the term module refers to an application specific integrated circuit (ASIC), an electronic circuit, a processor (shared, dedicated, or group) and memory that execute one or more software or firmware programs, a combinational logic circuit, and/or other suitable components that provide the described functionality.

Referring now to FIG. **2**, an exemplary physical layer device (PHY) **100** is depicted. The exemplary PHY **100** includes N media ports. In this implementation, N is equal to four. The N ports include a fiber 1000BASE-X first port **102**, a parallel 10GBASE-X second port **104**, a LAN/WAN serial 10GBASE-R/10GBASE-W third port **106**, and a copper

10GBASE-T/1000BASE-T/100BASE-TX/10BASE-T fourth port **108**. One skilled in the art will recognize that a PHY may have additional or fewer media ports, and the media ports may be of different type.

The media ports **102**, **104**, **106**, and **108** communicate with a media independent module **110**. The media independent module **110** provides a media independent interface **112**, such as with XGMII/GMII/MII signals, as shown in the exemplary PHY **100**. Alternatively, the interface may be a XAUI interface, or an extended XGMII interface, disclosed in "Media And Speed Independent Interface," U.S. patent application Ser. No. 11/114,842, filed Apr. 26, 2005, which is hereby incorporated by reference in its entirety.

Each of the media ports is able to sense when there is energy (or activity) on its physical media. The first media port **102** is shown receiving signal G_INP/N and transmitting G_OUTP/N. The second media port **104** is shown receiving signals X_INP/N[3:0] and transmitting X_OUTP/N[3:0]. The third media port **106** is shown receiving signal S_INP/N and transmitting S_OUTP/N. The fourth media port **108** is shown communicating signals MDIP/N[3:0]. These signals are media and implementation dependent. As described below, the media independent module **110** chooses one media port to connect with the media independent interface **112**.

Each of the media ports is capable of sensing whether there is activity (or energy) on its physical medium. This information is communicated to the media independent module **110** in the form of activity signals. Each of the media ports also communicates its network link status to the media independent module **110** in the form of link signals. One skilled in the art will recognize that the activity and link signals may be multiplexed over the same physical connection.

Referring now to FIG. **3**, a functional block diagram of an exemplary media selection system for a PHY is presented. A media selector module **142** communicates with a priority storage module **144**. The media selector module **142** communicates with at least two media ports **146**. The priority storage module **144** contains information regarding priority of the media ports **146**, i.e., which media port is preferred with respect to other media port for establishing a connection. The priority information assigns a distinct priority to each media port **146**, such that a list can be formed with the highest priority media port at the top and the lowest priority media port at the bottom. The media selector module **142** uses the priority information to maintain a link on the highest priority media port **146** that is possible. This priority information may be default or pre-programmed values, or may be set by the end user.

Referring now to FIG. **4**, a flow chart depicts exemplary steps taken by the media selector module **142** in determining which media port will be selected. Control starts at step **202** and transfers to step **204**. In step **204**, control attempts to establish links on all of the media ports. Control then transfers to step **206**, where the established link of the highest priority port is chosen and all other links are blocked. Blocked links operate in a minimal power mode, with only a low-power circuit to detect energy on the physical media. Control then transfers to step **208**. In step **208**, control determines whether energy is sensed on a higher priority port. If so, control transfers to step **210**; otherwise, control remains in step **208**.

In step **210**, ports with a priority below the higher priority port of step **208** are blocked. Optionally, the lower priority port on which a link is currently established can remain on, pending a link being established on the higher priority port of step **208**. Power constraints of the PHY **18** may only allow for one link at a time, in which case all lower priority ports will be blocked. In step **212**, a timer is set, and upon expiration of the timer, control transfers to step **214**. The timer value is set based on the time typically (or alternately, maximally) required for the media of the higher priority port of step **208** to establish a link. In step **214**, all links are unblocked and control returns to step **206**.

Referring now to FIG. **5**, a state diagram of an exemplary media selection system according to the principles of the present invention is presented. In this exemplary media selection system, four media ports and therefore four corresponding priority levels are present. Each media port is assigned a distinct priority level. The media port with the highest priority (the most preferable network link) is referred to as port one, the media port with the second highest priority is port two, etc. One skilled in the art will recognize that more or fewer ports may be employed. Control begins in state **300**, where all four ports are unblocked and each attempts to establish a link. If a link is established on port one, control transfers to state **302**. If no link is established on port one, but a link is established on port two, control transfers to state **304**; otherwise, if a link is established on port three, control transfers to state **306**; otherwise, if a link is established on port four, control transfers to state **308**.

In state **302** ports two through four are blocked. If the established link goes down, control returns to state **300**. In state **304** ports one, three, and four are blocked. If the established link goes down, control returns to state **300**. If, in state **304**, energy is sensed on port one, control transfers to state **310**. In state **310** ports two, three, and four are blocked and a timer is started. The timer value is based on the typical (or optionally, maximum expected) time required for a link to be established on the physical media used by port one. When the timer is done, control transfers to state **300**. This timed delay gives the (preferred) port one a head start in establishing a link.

In state **306** ports one, two, and four are blocked. If the established link goes down, control returns to state **300**. If, in state **306**, energy is sensed on port one, control transfers to state **310**. Otherwise, if energy is sensed on port two, control transfers to state **312**. In state **312** ports three and four are blocked and a timer is started with a value corresponding to port two. When the timer is done, control returns to state **300**.

In state **308** ports one through three are blocked. If the established link goes down, control transfers to state **300**. If energy is sensed on port one, control transfers to state **310**. Otherwise, if energy is sensed on port two, control transfers to state **312**; otherwise, if energy is sensed on port three, control transfers to state **314**. In state **314** port four is blocked and a timer is started with a value corresponding to port three. When the timer is done, control returns to state **300**. Selective blocking depends upon power requirements. If the physical layer device can support the power draw of multiple simultaneous links, the port with a currently active link may remain unblocked until the higher priority port has actually established a link.

One skilled in the art will recognize that there are various methods of detecting and qualifying energy. A partial discussion of how to detect energy on physical media is presented in "Ethernet Automatic Media Selection Logic," U.S. patent application Ser. No. 09/991,046, filed Nov. 21, 2001, and "Ethernet Automatic Media Selection Logic With Preferred Medium Selector," U.S. patent application Ser. No. 10/435,301, filed May 9, 2003, which are both hereby incorporated by reference in their entirety.

Those skilled in the art can now appreciate from the foregoing description that the broad teachings of the present invention can be implemented in a variety of forms. Therefore, while this invention has been described in connection with particular examples thereof, the true scope of the invention should not be so limited since other modifications will become apparent to the skilled practitioner upon a study of the drawings, the specification and the following claims.

What is claimed is:

1. A media selection system comprising:

a plurality of media ports, each of the plurality of media ports being coupled to a corresponding physical medium, each of the plurality of media ports being configured to

generate an activity signal indicting whether activity is sensed on the corresponding physical medium associated with the media port, and

generate a link status signal indicating a network link status through the corresponding physical medium associated with the media port;

a priority storage module configured to contain priority information, the priority information setting forth a priority for establishing a link through each of the plurality of media ports; and

a media selector module configured to

select a first media port of the plurality of media port through which a link will be maintained based on (i) the link status signal generated by each of the plurality of media ports and (ii) the priority information, and

block all other links through media ports of the plurality of media ports other than the first media port,

wherein, in response to an activity signal being generated by a second media port having a higher priority than the first media port, the media selector is configured to block all other media ports other than the second media port responsive to a link being established through the second media port.

2. The media selection system of claim **1**, wherein the priority information associates each of the plurality of media ports with a unique priority level.

3. The media selection system of claim **1**, wherein the priority storage module comprises one or more of an application specific integrated circuit (ASIC), an electronic circuit, a processor, a combination logic circuit, or a memory.

4. The media selection system of claim **1**, wherein the first media port has a highest priority among other media ports of the plurality of media ports having an established link.

5. The media selection system of claim **1**, wherein the plurality of media ports comprise one or more of a fiber 1000BASE-X port, a parallel 10GBASE-X port, a serial 10GBASE-R/10GBASE-W port, or a copper 10GBASE-T/1000BASE-T/100BASE-TX/10BASE-T port.

6. The media selection system of claim **1**, further comprising a media independent interface configured to connect to the first media port.

7. The media selection system of claim **6**, wherein the media independent interface comprises a XAUI interface.

8. The media selection system of claim **6**, wherein the media independent interface comprises an extended XGMII interface.

9. A method for selecting a media port from among a plurality of media ports through which a link will be maintained, each of the plurality of media ports being coupled to a corresponding physical medium, the method comprising:

for each of the plurality of media ports, generating a link status signal indicating a network link status through the corresponding physical medium associated with the media port;

selecting a first media port of the plurality of media port through which a link will be maintained based on (i) the link status signal generated by each of the plurality of media ports and (ii) priority information, wherein the priority information sets forth a priority for establishing a link through each of the plurality of media ports; and

blocking all other links through media ports of the plurality of media ports other than the first media port,

wherein, in response to activity being sensed on a corresponding physical medium associated with a second media port having a higher priority than the first media port, blocking all other media ports other than the second media port responsive to a link being established through the second media port.

10. The method of claim **9**, wherein the priority information associates each of the plurality of media ports with a unique priority level.

11. The method of claim **9**, wherein the first media port has a highest priority among other media ports of the plurality of media ports having an established link.

12. The method of claim **9**, wherein the plurality of media ports comprise one or more of a fiber 1000BASE-X port, a parallel 10GBASE-X port, a serial 10GBASE-R/10GBASE-W port, or a copper 10GBASE-T/1000BASE-T/100BASE-TX/10BASE-T port.

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